

IN THE CLAIMS:

Claims 3, 4, 11-15 and 17-20 were previously cancelled. Claim 22 has been amended herein. All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of Claims:

1. (Previously presented) A method for correcting a defective ball grid array on an electronic component workpiece, the method comprising:
disposing at a first location a workpiece having an array of solder balls secured thereto; and
without moving the workpiece from the first location:
identifying at least one defective solder ball associated with a corresponding attachment site of the array of solder balls on the workpiece; and
extracting the at least one defective solder ball with a capillary tube to vacate the corresponding attachment site by individually heating the at least one defective solder ball to a molten state and removing molten solder from the corresponding attachment site into the capillary tube by capillary action;
and replacing the at least one defective solder ball with a nondefective solder ball placed on the vacated corresponding attachment site with the capillary tube while maintaining other solder balls of the array of solder balls in undisturbed arrayed attachment to the workpiece.
2. (Previously presented) The method of claim 1, wherein the at least one defective solder ball comprises a plurality of defective solder balls, and further comprising extracting and replacing each defective solder ball of the plurality of defective solder balls while maintaining said other solder balls of the array of solder balls in said undisturbed arrayed attachment to the workpiece.

Claims 3-4 (Cancelled)

5. (Previously presented) The method of claim 1, further comprising assisting the capillary action by application of a vacuum.

6. (Previously presented) The method of claim 1, further comprising lifting the nondefective solder ball with the capillary tube, positioning the nondefective solder ball on the vacated corresponding attachment site and locally heating only the nondefective solder ball at least to a temperature to cause the nondefective solder ball to bond to the corresponding attachment site.

7. (Previously presented) The method of claim 6, further comprising lifting the nondefective solder ball using a vacuum provided through the capillary tube, and locally heating the nondefective solder ball through the capillary tube.

8. (Previously presented) The method of claim 6, further comprising applying flux to the nondefective solder ball prior to the positioning thereof on the vacated corresponding attachment site.

9. (Previously presented) The method of claim 6, further comprising applying flux to the vacated corresponding attachment site prior to the positioning of the nondefective solder ball thereon.

10. (Previously presented) A method for removing and replacing a solder ball from an attachment site of a ball grid array on an electronic component workpiece, the method comprising:
placing an electronic component workpiece having a ball grid array thereon at a location; and
without moving the electronic component workpiece from the location:

aligning a capillary tube over a solder ball of the ball grid array on the electronic component workpiece;
lowering the capillary tube to contact the solder ball from above;
heating the solder ball with heat conducted from a heat source through the capillary tube sufficiently to reduce the solder thereof to a molten state;
drawing a vacuum through the capillary tube to facilitate drawing the solder in a molten state thereinto;
retrieving a replacement solder ball from a source of replacement solder balls using the capillary tube;
aligning the capillary tube over the attachment site;
lowering the capillary tube to place the replacement solder ball in contact with the attachment site;
heating the replacement solder ball through the capillary tube at least sufficiently to cause the replacement solder ball to bond to the attachment site; and
retracting the capillary tube and releasing the replacement solder ball.

Claims 11-15 (Cancelled)

16. (Previously presented) A method for extracting and removing at least one defective solder ball from an attachment site in a ball grid array of an electronic component workpiece, comprising:
placing an electronic component workpiece on a support at a location; and
without moving the electronic component workpiece from the location:
viewing a ball grid array of the electronic component workpiece under magnification to identify and locate at least one defective solder ball in the ball grid array;
positioning a ball pickup head comprising a capillary tube over the at least one defective solder ball and vertically extending the capillary tube to contact the at least one defective solder ball;

applying heat from a heater through the capillary tube to the at least one defective solder ball to reduce it to a molten state;
removing the molten solder from the attachment site with the capillary tube by at least one of capillary action and applying a vacuum to the molten solder material through the capillary tube;
retrieving a good solder ball from a source of good solder balls using the capillary tube;
positioning the capillary tube over the attachment site;
extending the capillary tube to place the good solder ball in contact with the attachment site;
heating the good solder ball with the heater through the capillary tube at least sufficiently to cause the good solder ball to bond to the attachment site; and
retracting the capillary tube to release the solder ball.

Claims 17-20 (Cancelled)

21. (Previously presented) The method of claim 16, further comprising, after removing the molten solder from the attachment site with the capillary tube:
retrieving the good solder ball from the source of good solder balls with the capillary tube by applying a vacuum through the capillary tube; and
applying flux to at least one of the one good solder ball and the attachment site.

22. (Currently amended) The method of claim 16, further comprising performing at least some of the ~~steps of the method~~ for extracting and removing at least one defective solder ball under control of a programmed microprocessor.

23. (Previously presented) The method of claim 22, wherein viewing the ball grid array under magnification is performed using a machine vision system.

24. (Previously presented) The method of claim 23, further including using the machine vision system in combination with said programmed microprocessor and data stored in memory to compare the viewed ball grid array with a model ball grid array and said location of the at least one defective solder ball in the viewed ball grid array.

25. (Previously presented) An apparatus for extracting and replacing an individual solder ball mounted on an attachment site on an electronic component workpiece, the apparatus comprising:

a support configured to receive an electronic component workpiece thereon;

a solder ball contact head configured to remove an individual solder ball from the electronic component workpiece and, without removal of the electronic component workpiece from the support, to replace the removed solder ball with another solder ball, the solder ball contact head comprising:

a capillary tube including a distal end having an inside diameter less than a diameter of an individual solder ball of a plurality of solder balls mounted in an array over a surface of the electronic component workpiece; and

a heating device operably coupled to the capillary tube;

a structure for aligning the capillary tube with the mounted individual solder balls in substantially transverse orientation to the electronic component workpiece surface; and

an assembly for controllably extending and retracting the capillary tube toward and away from the surface of the electronic component workpiece.

26. (Original) The apparatus of claim 25, further including a vacuum source selectively operably coupled to the capillary tube for drawing a vacuum therethrough.

27. (Previously presented) The apparatus of claim 25, further including a structure for effecting alignment of the support in X- and Y-directions.

28. (Previously presented) The apparatus of claim 25, further including a viewing apparatus configured for magnification and orientable over the surface of the electronic component workpiece when the electronic component workpiece is received on the support.

29. (Original) The apparatus of claim 28, wherein the viewing apparatus includes at least one of at least one eyepiece for viewing and a camera for generating an electronic image.

30. (Original) The apparatus of claim 28, further including a light source orientable for illuminating the surface of the electronic component workpiece.

31. (Previously presented) The apparatus of claim 30, wherein the solder ball contact head is configured for transmission of at least a portion of the illumination from the light source therethrough.

32. (Previously presented) The apparatus of claim 31, wherein the solder ball contact head is configured with a window in alignment with a bore extending through the capillary tube.

33. (Previously presented) The apparatus of claim 31, wherein the solder ball contact head is configured with at least one optical fiber positioned to receive light from the light source and extending to a location to transmit the received light onto the surface of the electronic component workpiece.

34. (Previously presented) The apparatus of claim 25, further comprising a source of nondefective solder balls in proximity to the solder ball contact head.

35. (Previously presented) The apparatus of claim 25, wherein said structure for aligning the capillary tube comprises a machine vision apparatus including a camera, a magnifying lens, at least one programmed microprocessor and memory having data stored therein representative of the surface of the electronic component workpiece and topography thereof.

36. (Previously presented) The apparatus of claim 35, wherein the memory further includes stored data usable by the at least one programmed microprocessor for identifying defective solder balls within the array.

37. (Previously presented) The apparatus of claim 36, wherein the at least one programmed microprocessor is programmed to control at least some movements of the solder ball contact head and operation of the heating device.

38. (Previously presented) The apparatus of claim 25, wherein the solder ball contact head is resiliently biased to yield responsive to contact of the capillary tube with a solder ball of the array.

39. (Previously presented) The apparatus of claim 25, further including a retraction device for selectively retracting the capillary tube toward the solder ball contact head.

IN THE DRAWINGS:

The attached sheet of drawings includes a change to FIG. 17. This sheet replaces the original sheet including FIG. 17.

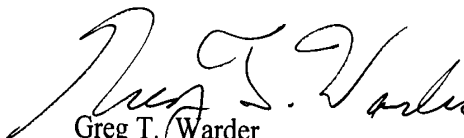
REMARKS

This amendment corrects errors in the text and drawings. Entry is respectfully solicited.

FIG. 17 has been amended herein. Specifically, FIG. 17 has been revised to change the reference numeral "10" to --10A-- to eliminate redundancy with previously used reference numerals. No new matter has been added.

This amendment is submitted prior to or concurrently with the payment of the issue fee and, therefore, no petition or fee is required. No new matter has been added.

Respectfully submitted,



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GTW/csw

Enclosures: Replacement Sheet

Annotated Sheet Showing Changes

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